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Research article

Inducing forward head posture recalibrates the valuation of future rewards

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ABSTRACT

Background: The ability to prioritize long-term goals over immediate rewards is a cornerstone of human self-regulation and life-course success. Emerging evidence suggests that axial postural orientation provides a continuous stream of proprioceptive feedback that modulates this temporal valuation process. Using the framework of grounded cognition, this study investigated whether inducing Forward Head Posture (FHP) influences the valuation processes underlying self-regulation and future-oriented choice.
Methods: Healthy young adults (N = 59) performed a Delay Discounting Task (DDT) and a control simple reaction time (SRT) task in one of two conditions: FHP or Neutral Head Posture (NHP). Choice behavior was modeled using Generalized Linear Mixed Models (GLMM) to isolate shifts in reward-valuation probability.
Results: Participants in the FHP condition showed a significantly higher probability of choosing smaller-sooner rewards compared to the NHP group ($p = .004$). The groups did not differ on SRT latency ($p = .82$), indicating that the FHP effect reflects a selective shift in executive decision-making rather than a general decline in processing capacity.
Conclusion: These findings provide experimental evidence that the head-neck-torso relationship is a relevant variable in the functional architecture of self-regulation. Transient FHP appears to shift the organism toward an immediacy-biased state, suggesting that postural orientation is an integral component of the physiological processes that influence executive function. This has direct implications for neurorehabilitation and the study of behavioral self-control.

1. Introduction

Impulsivity is a multifaceted construct that includes deficits in forethought, a preference for novel and stimulating environments, a propensity for rash, unplanned actions, and a tendency to choose immediate gratification over longer-term goals. It therefore represents a fundamental challenge to human decision-making and self-regulation. While frequently studied in the context of clinical conditions such as addiction and attention deficit hyperactivity disorder (ADHD) [1], impulsive tendencies also manifest in healthy populations as poor dietary or financial choices, excessive alcohol consumption, risky sexual activities, or neglecting one's studies for more amusing pursuits [2]. Because these choices can determine life-course success, identifying the factors that modulate the valuation of future rewards is a critical task for behavioral science. In experimental psychological traditions, this trade-off is classically operationalized as the capacity for delay of gratification—the ability to resist an immediate temptation in pursuit of a more valuable future outcome.

Although propensity to delay gratification is often treated as a stable trait-like characteristic, exhibiting modest temporal stability across months and years and serving as a transdiagnostic marker of clinical psychopathology [3], individual choice trajectories remain highly sensitive to acute state-like modifications. This state-trait duality suggests that while an individual maintains a baseline discounting rate, immediate situational, somatic, or environmental cues can dynamically recalibrate valuation on a moment-to-moment basis [4]. For instance, visual exposure to natural environments [5], increasing connection with the future self through age-progressed digital avatars [6], and a hypnotic

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0166-4328/© 2026 Elsevier B.V. All rights are reserved, including those for text and data mining, AI training, and similar technologies.

suggestion of safety [7] have all been shown to increase the value of delayed rewards. If psychological and environmental contexts can so readily shift the probability of impulsive choice, it stands to reason that somatic states, including axial postural orientation, may serve as a continuous physiological constraint on the neural systems governing self-regulation.

The framework of grounded cognition [8] proposes that since cognition, perception, and action are all part of the same neural system, they can mutually influence one another. Experimental research shows that when people lean forward, they exhibit increased neural responsiveness to appetitive stimuli [9] and faster emotional judgements [10]. Forward head posture (FHP) also increases physiological arousal during a stressful task [11]. Chronic FHP correlates with poor executive function [12], poor sensory conduction [13], and inaccurate proprioception [14], while transient, induced FHP leads to faster reaction times [15-17]. These effects may be driven by a short-term, localized increase in corticospinal excitability [18], possibly mediated by altered proprioceptive feedback from the dense population of cervical muscle spindles.

This state of heightened excitability may be understood through the lens of motivational direction. Forward-leaning postures are physically and neurally associated with approach-motivated states: a biological 'readiness to act' in pursuit of a goal [9]. Intertemporal choice relies on competing neural systems: an evolutionary older, limbic-associated system that responds preferentially to immediate rewards, and a lateral prefrontal and parietal system that supports long-term valuation and executive inhibition [19]. In a high-approach state, the brain prioritizes immediate reward acquisition over long-term inhibition. By contrast, an upright or neutral posture is associated with higher-level executive control and the ability to maintain a 'wait-and-see' outlook. Thus, inducing FHP may shift the individual into a transient, high-approach state that makes immediate rewards psychologically more salient. In the context of a decision task, such action-readiness could predispose the system toward favoring immediate engagement over the more abstract evaluation of future outcomes.

A common task for assessing temporal perspective in the lab is the Delay Discounting Task (DDT) [20]. The DDT is a non-speeded, value-based task in which participants make a series of choices between two rewards that vary in both magnitude and delay. Mathematically, this subjective devaluation of future rewards is best described by a hyperbolic decay function, meaning that value drops steeply over short delays but flattens out over longer horizons [21,22]. A tendency to choose a sooner, smaller amount over a larger, later amount indicates greater preference for immediate gratification [23]. The DDT is a reliable measure of behavioral preference, and its outcomes are a significant predictor of long-term health, financial stability, and professional achievement [24,25].

Our primary hypothesis in this study was that experimentally inducing short-term FHP would lead to higher probability of choosing smaller-sooner rewards in a delay discounting task, relative to performance in a neutral head posture (NHP). We also predicted that in a separate, speeded task with the same participants, simple reaction times would be faster in the FHP condition, as previously seen.

2. Methods

2.1. Participants

Participants were 59 university students (n = 30 FHP, n = 29 NHP) recruited from the undergraduate research pool (SONA systems) at a large public university in the Inland Northwest region of the USA. Due to an administrative oversight, specific participant ages were not collected. However, because the sample was drawn entirely from this institutional pool, the participants represent a relatively homogenous, predominantly white, young-adult demographic. Inclusion criteria were the capacity to hear and understand the instructions, read the information on the computer screen, and complete the task without pain. Of the initial 59 participants, 3 were excluded due to non-discriminated choice behavior (i.e., invariant or extreme preference for one reward type regardless of value or delay; see 2.4.2), leaving a final analytical sample of 56 (n = 29 FHP, n = 27 NHP). The study was approved by the University of Idaho Review Board, and participants provided written informed consent. Baseline self-report measures were collected to ensure group equivalence across several factors, including sex, trait impulsivity (BIS−11; [26]), trait mindfulness (MAAS; [27]), and neck pain/disability (NDI; [28]). See Table 1.

2.2. Experimental design

The study used a between-groups design to eliminate demand characteristics and carryover effects, including postural fatigue, choice anchoring, and task learning, that would confound a repeated-measures posture manipulation. Following random assignment to either an FHP or NHP condition, participants completed both the SRT task and DDT, while maintaining their assigned postural orientation.

2.3. Setup and posture manipulation

Workstation setup, marker placement, neck taping, and neck angle calculation followed [15]. The computer chair, keyboard, and monitor were adjusted for each subject's anthropometry to facilitate a neutral baseline position. Posture was monitored in real time using an 8-camera Vicon Bonita motion capture system (100 Hz) and The *MotionMonitor* xGen software (Innovative Sports Training, Chicago, IL). Reflective markers were placed on the head, neck, and 12th thoracic vertebra to estimate joint center locations and capture trunk orientation.

Using The *MotionMonitor*'s kinematic engine, the neck angle was defined by the vertex at the seventh cervical vertebra (C7) with one vector extending to the atlanto-occipital joint and a second vector extending horizontally forward from C7. The angles were defined based on joint centers rather than on the skin surface to provide a more accurate biomechanical representation of the head's translation relative to the spine. Baseline posture was captured before postural manipulation was implemented. See Table 1. To maintain the assigned somatic state throughout the cognitive tasks, surgical tape was applied to both sides of the neck while the participant was in the target orientation (see Fig. 1). The tape provided tactile biofeedback; if participants drifted a degree from the target angle, the tape became taut, prompting a return to position. Participants were asked to use the feedback from the tape to maintain their assigned head position during both tasks.

2.4. Protocol, tasks and data analysis

Participants were instructed in the SRT task, then reminded to maintain their assigned posture before beginning the task. After

Table 1
Group comparisons for psychometric scales and cervical angles. BIS = Barratt Impulsivity Scale. MAAS = Mindful Attention and Awareness Scale. NDI = Neck Disability Index.

Measure	FHP Group (n = 29)	NHP Group (n = 27)	Test Statistic	p-value
Demographics				
Sex	F= 17; M= 12	F= 15; M= 12	$\chi^2 = 1.3$	.73
Psychometric Scales				
BIS−11 (Total)	67.9 ± 10.8	67.8 ± 13.0	t = 0.03	.97
MAAS	52.0 ± 11.6	52.5 ± 12.8	t = −0.16	.72
NDI	6.6 ± 4.5	5.7 ± 4.1	t = 0.85	.40
Cervical Angle (°)				
Baseline	79.0 ± 5.7	80.3 ± 5.5	t = 0.9	.38
Task: Mean ± SD	77.8 ± 5.1	80.9 ± 4.8	t = 2.3	.02

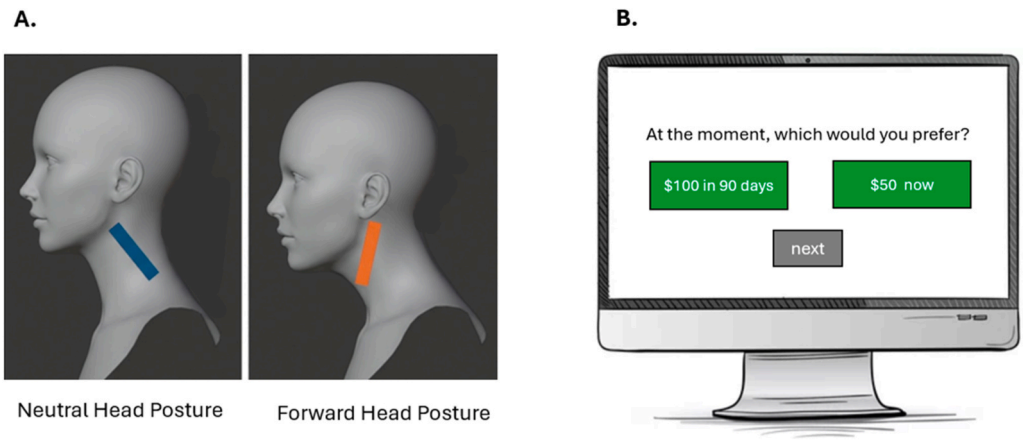

Fig. 1. *Experimental Procedures.* A. Tape placement for induction of experimental postures. Adapted from [15] under a Creative Commons Attribution 4.0 International License (CC BY 4.0). B. Sample question from delay discounting task.

completing the SRT task, they received instructions for the DDT task and another reminder to maintain their assigned posture before beginning that task.

2.4.1. SRT

The SRT task comprised a single block of 80 trials, with a variable inter-stimulus-interval (250–2500 ms), presented via Psychology Experiment Building Library (PEBL); [29]. The stimulus was a bright white sans serif 'X' about 1 cm tall, appearing in the center of a black screen in front of the participant. Total task duration was around 3 min, depending on participants' response speeds. Instructions were: "You are about to take part in a simple task. In this task, you will see the symbol 'X.' Whenever you see this symbol, depress the space bar as quickly as possible." To isolate processing-speed effects from lapses in attention, SRT outliers were trimmed at ±3.0 SD from each participant's mean. Because the Simple Reaction Time (SRT) task served as a baseline control to evaluate group-level processing speed rather than trial-level choice dynamics, mean reaction times were compared between conditions using standard group-level statistics. Data were analyzed using a two-tailed, between-groups *t*-test.

2.4.2. DDT

Following the procedure described by [30] and using the author's original task presentation software, we employed the psychophysical method of constant stimuli. Standard and alternative items (amounts and delays) were paired and presented in a fully randomized sequence, rather than the ascending or descending order used in the method of limits. This randomized approach was selected to mitigate habituation and expectation effects, ensuring that each participant's choice remained independent of the previous trial. To further minimize response bias, the spatial orientation of larger-later (LL) and smaller-sooner (SS) rewards was randomized across all trials.

The trial set included comparisons where the immediate reward exceeded the delayed reward (e.g., $105 now vs. $100 later). These trials contributed to the overall rigor of the randomized presentation by disrupting predictable responding [30]. Total task duration averaged around seven minutes. For each trial, the LL option was fixed at $100 with a specified delay (0, 7, 30, 90, 180, or 365 days). The SS option varied across 23 fixed dollar amounts ($0, $2.50, and $5–$105), with a fixed 0-day delay. Responses were coded binarily (e.g., 1 for the SS option, 2 for the LL option). The single cell representing identical parameters ($100 now vs. $100 now) was a non-presented identity trial. With six delays and 23 monetary amounts, minus the non-presented identity trial, there were 138 total trials.

Instructions to the participant were: "You will now take part in a decision-making task. For each question, you can choose between 2 options by clicking on your choice using the computer mouse and then clicking 'next question.' You can change your selection as often as you like, and there is no right or wrong answer; we are interested in your personal preferences. Once you have decided which option you prefer, register your preference and go on to the next question by clicking on the 'next' box. One option will always be some amount of money available now. The other option will always be a fixed amount of money available after a waiting period. The waiting period will vary between 0 days (now) and 365 days. Imagine that the choices you are making are real - that if you choose 'money now' you would receive that amount of money at the end of the task and that if you choose 'money later' that you would actually have to wait that amount of time before receiving the money." Experimenters explicitly clarified that all rewards were hypothetical. Participants completed the choice trials self-paced, with no response time limit enforced per trial, ensuring that choices reflected stable preferences rather than rushed responses.

2.4.3. DDT analysis

Data were analyzed in R [31]. Data parsing, filtering, and restructuring were performed using the tidyverse suite of packages [32], and reproducible path management was maintained via the here package [33]. Hierarchical generalized linear mixed-effects modeling (GLMM) with a logistic link function was executed using the lme4 package [34]. This approach has been established as an effective method for modeling the probabilistic nature of choice behavior in discounting tasks [35] and is particularly robust to the trial-level noise introduced by randomized stimulus presentation [36].

While individual hyperbolic discounting parameters (k) are common in titrated designs, a trial-level GLMM was selected here to maximize data retention and stability. Individual non-linear curve-fitting on fixed-grid binary choice data can introduce severe parameter inflation and outlier distortion [37]. Analyzing the raw trial-by-trial choices via a mixed-effects logistic framework circumvents these convergence limitations while remaining theoretically grounded within a log-transformed utility framework

Prior to analysis, we excluded participants who exhibited non-discriminated choice behavior, defined as choosing the larger-later reward on less than 10% or more than 90% of trials, as such patterns indicate a lack of sensitivity to the task variables [38]. The model treated the participant's choice (Immediate vs. Delayed) as the dependent variable, with condition (FHP vs. NHP), delay cost, and their interaction as fixed effects. A random intercept for subject ID was included to account for individual differences in baseline discounting. The critical measure of interest was the condition × delay cost interaction, which represents the difference in the rate of discounting between postural groups, analogous to the difference in the discount rate ('k') found in traditional

hyperbolic modeling.

3. Results

3.1. Baseline comparisons and manipulation check

Analysis of self-reported sex, mindfulness, impulsivity, and neck pain confirmed balanced group allocation. Kinematic validation confirmed that baseline postures for the groups were non-significantly different, and the groups maintained distinct postural shifts relative to their own baselines during the tasks. See Table 1.

3.2. DDT

Participants in the FHP condition demonstrated significantly larger delay discounting than participants in the NHP condition. Three participants were excluded from the DDT analysis due to extreme choice behavior (nonsensitive to task variables) according to criteria defined in 2.4. The GLMM analysis revealed a significant interaction between condition and delay cost ($\beta = 0.195$, SE = 0.067, $z = 2.91$, $p = .004$), indicating that participants in the FHP condition were more sensitive to the cost of waiting and discounted future rewards at a steeper rate than those in the NHP condition. See Fig. 2. The full model specifications, including fixed effects, random effects variance, and goodness-of-fit statistics, are presented in Table 2.

3.3. SRT

The SRT difference in the full sample was negligible and non-significant. Two participants' responses were identified as outliers according to criteria defined in 2.4 and removed. Mean (SD) RTs were 334 (31) ms in the NHP condition and 332 (31) ms in the FHP condition, $t(53) = 0.23$, $p = .82$, Cohen's $d = 0.06$, 95% CI [−0.46, 0.59].

4. Discussion

4.1. Overview of findings

The objective of this study was to investigate whether a transient postural manipulation could modulate value-based decision-making in a healthy population. As hypothesized, participants in the FHP condition demonstrated a significantly higher probability of choosing smaller-sooner rewards compared to those in the NHP condition. These results demonstrate that FHP acts as a specific situational modulator of future-oriented decision-making, biasing individuals toward immediate gratification.

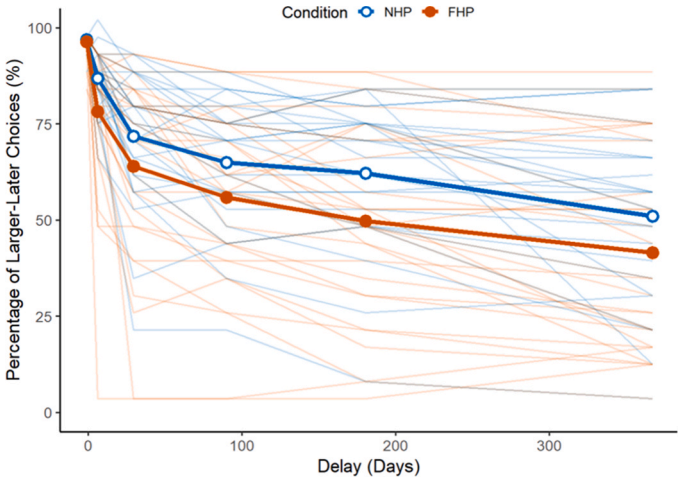

Fig. 2. *Behavioral Choice Probabilities.* Logistic curves represent the observed mean probability of choosing the larger-later reward ($100) as a function of delay (days) and postural condition. The line with white-filled markers indicates the Neutral Head Posture (NHP) condition, while the line with dark-filled markers indicates the Forward Head Posture (FHP) condition. The significant condition × delay cost interaction ($p = .004$) is evidenced by the steeper decline in choice probability for the FHP group, indicating decreased valuation of future rewards. Thin lines show individual subject data.

Table 2
Multilevel logistic regression model predicting larger-later reward choice. NHP served as the reference group for Condition. Predictors were scaled during modeling. The negative sign for the mathematical interaction coefficient ($\beta = -0.195$) reflects a steeper negative slope for the FHP group when predicting the choice of the delayed reward, which corresponds to a greater conceptual discount rate for the FHP condition as reported in the text. The total number of observations (7728 trials) reflects the full clean dataset across the 56 analytical participants following the exclusion of 3 participants due to invariant responding.

Predictor	Estimate (β)	Standard Error (SE)	z-value	p-value
Fixed Effects				
Intercept	−2.346	0.274	−8.57	< .001
Utility Diff (Scaled)	5.077	0.158	32.18	< .001
Delay Cost (Scaled)	−0.883	0.049	−18.15	< .001
Condition (FHP)	0.348	0.365	0.95	.340
Delay Cost x Condition (FHP)	−0.195	0.067	−2.91	.004
Random Effects	Variance	SD		
Subject ID (Intercept)	1.798	1.341		
Model Fit Statistics				
Number of Observations	7728			
Number of Groups (Subjects)	56			
AIC / BIC	6131.2 / 6172.9			
Log Likelihood	−3059.6			

Importantly, FHP did not significantly affect simple reaction time. The absence of a group difference on the SRT task serves as a critical baseline control, confirming that the shift observed in delay discounting was not driven by motor sluggishness, general fatigue, or a global decline in processing capacity. By ruling out these global confounds, our design established a direct causal link between posture and intertemporal choice in a healthy population, demonstrating that the postural manipulation specifically targeted the executive processes involved in impulse control and future-value simulation.

This direction of effect, a systematic shift toward smaller-sooner choices, aligns with literature linking chronic FHP to reduced executive function [12], impaired sensory conduction [13], and degraded cervical proprioception [14]. Because selecting larger-later rewards relies on intact executive control and sensory integration to simulate future outcomes and inhibit immediate impulses, our findings suggest a shared underlying mechanism: even acute postural displacement may tax the neural efficiency required for high-level self-regulation. Future research should untangle whether these shared neurophysiological pathways can be targeted to preserve cognitive bandwidth during complex choice tasks.

4.2. Consideration of potential postural discomfort

Because FHP is sometimes associated with neck pain, we evaluated whether our behavioral findings could be driven by sub-threshold postural strain. Multiple lines of evidence suggest that this explanation is unlikely. Our 15-minute testing time represents less than 10% of the typical exposure thresholds associated with occupational neck pain [39, 40], and the transient 1.2 ° forward shift induced in our experimental group is roughly one-fourth of the discrepancy typically seen in studies of chronic neck pain [41]. Furthermore, participants in our

post-experiment debriefings reported no physical strain or discomfort at any point during testing.

Even if subthreshold pain was present, prior research demonstrates that short-term mild discomfort does not increase choice discounting. Although *chronic* pain has been associated with increased delay discounting, well-controlled studies demonstrate that this relation is fully mediated by psychological variables, including perceived stress [42] and pain catastrophizing [43]. In acute pain manipulations, behavioral outcomes are intensity-dependent: choice discounting increases under severe pain calibrated to maximum tolerance [44], but not under moderate pain [45]. Thus, physical discomfort alone is an insufficient explanation for our findings.

From a theoretical perspective, grounded cognition suggests that bodily signals and decision-making are naturally intertwined. Rather than viewing subtle physical feedback as a potential confound, future research should explore it as a potential mechanism, using tools like electromyography to track neck muscle activity and fatigue over longer tasks.

4.3. Theoretical and practical implications

The grounded cognition framework [8] suggests that executive functions are constrained by the neural systems used for perception and action. Mechanistically, forward translation of the head may function as a bottom-up somatic nudge, inducing a state of action-readiness [46]. By increasing corticospinal excitability and priming the motor system before movement occurs [11,18,47], this physical orientation lowers the threshold for immediate action, prioritizing approach-motivation over the effortful cognitive inhibition required to value distant rewards [9].

From an evolutionary perspective, a neutral posture signals low immediate demand, facilitating long-term executive planning, while a forward head posture physically mimics immediate environmental engagement, such as tracking a threat or seizing a nearby resource [48,49]. The importance of these findings is underscored by the absence of somatic factors in systematic reviews of impulsivity-focused interventions. While Rung & Madden [50] and Scholten et al. [4] evaluated a diverse array of strategies, including mindfulness, episodic future thinking, and environmental cues, the physical body remains a notable blind spot in this literature. Our results indicate that the physical organization of the body is an integral, yet overlooked, dimension of self-regulation.

The potency of this somatic shift is highlighted by our experimental design. In prior studies establishing a motor advantage for induced neck flexion, participants in the FHP condition were forced into extreme postures of 80% maximal neck flexion, while participants in the neutral condition were stabilized using rigid chin rests to maximize physical differences between conditions [16,51]. By contrast, the present study used non-restrictive cues to induce mild postural shifts without rigid restraints. While this approach reduces the magnitude of response time facilitation, it offers a more ecologically valid reflection of routine office ergonomics. The fact that significant changes in intertemporal choice emerged under these mild behavioral conditions underscores the sensitivity of executive processing to subtle somatic conditions.

In modern digital environments, where prolonged smartphone and laptop use frequently induce sustained FHP, our physical ergonomics may be an unrecognized nudge toward impulsive consumption. This somatic state brings immediate performance benefits: a forward-leaning posture accelerates motor execution and shortens reaction times [17]. Minimizing latency across thousands of daily micro-actions cumulatively lowers interactive friction, optimizes task productivity, and is registered by the central nervous system as a state of heightened fluency [52,53], which may provide continuous subconscious reinforcement for maintaining a forward head position. However, chronically maintaining this high-approach configuration creates a fundamental trade-off, taxing the executive resources required for making good long-term health, financial, and life choices [2].

4.4. Study limitations

Subject characteristics: Precise demographic data on participant age were not collected due to administrative oversight; however, as noted in the Methods, all participants were recruited from a regional university student population in the Inland Northwest USA, resulting in a relatively homogenous, predominantly white and young-adult sample. It remains unknown whether these effects would generalize to other populations, such as older adults or those already experiencing compromised inhibitory control.

Cover story: The study did not include a cover story to mask the postural manipulation. While one recent meta-analysis shows that the presence or absence of a cover story does not affect outcomes in embodied cognition research [54], another suggests that the omission of one might induce demand characteristics [55]. However, the between-subjects nature of the design likely mitigated the risk of participants discerning the hypothesis.

Task differences: The SRT and DDT differed in task duration and execution order. The 3-minute SRT was always administered prior to the 7-minute DDT. Because these two tasks differed in length, cognitive load, and presentation order, direct performance comparisons between them are not possible. The SRT was included strictly as a pre-test control to verify baseline processing speed and simple motor latency across groups, rather than as a benchmark for task-level sensitivity.

Ecological validity: Although the DDT is the gold standard for laboratory assessments, it does not fully capture the complexity of real-world financial or health-related decisions. Relatedly, the study does not test whether effects would persist or compound over longer durations of FHP.

4.5. Future recommendations

Future research should evaluate the effect of postural interventions on executive function. Note that correcting posture is not as simple as telling individuals to "sit up straight." Effortful volitional correction acts as a secondary task that competes for executive resources, creating a dual-task cost [56]. Instead, researchers should investigate whether interventions that promote automatic neutral alignment, for instance through cervical proprioceptive training [57], structural restoration [58], backward walking [59] or somatic approaches like Alexander Technique [60,61] can also lead to a durable reduction in real-world impulsivity.

Additionally, future studies could incorporate neuroimaging to clarify the neurobiological mechanisms involved. For example, using EEG to examine whether FHP-induced shifts correlate with either reward positivity [7] or cortical frequency [62,63] could clarify the neurobiological mechanisms through which baseline posture influences decision-making.

5. Conclusions

The present study provides experimental evidence that inducing forward head posture significantly influences the valuation processes underlying self-regulation and future-oriented choice, as measured by delay discounting in a healthy university population. Our findings demonstrate that the physical relationship of the head to the torso can act as a mechanistic driver of economic choice, independent of trait impulsivity or habitual posture. These results suggest that FHP promotes a processing state that favors immediate execution over comprehensive calculation. Beyond its clinical implications for physical health, the restoration of neutral alignment may serve as a somatic tool for enhancing self-control and improving long-term decision-making.

CRediT authorship contribution statement

Rajal G. Cohen: Writing – review & editing, Writing – original draft,

Supervision, Software, Project administration, Methodology, Formal analysis, Data curation, Conceptualization. **C. Grant Billings:** Writing – review & editing, Supervision, Project administration, Methodology, Investigation, Data curation, Conceptualization. **Colby L. Hillend:** Writing – review & editing, Visualization, Data curation, Conceptualization. **Jason L. Baer:** Writing – review & editing, Software, Methodology.

Ethics declaration

Written informed consent to take part in the study and to publish the article has been obtained from all participants or their legal representatives. The privacy rights of participants have been observed.

This study was performed in compliance with relevant laws, regulatory frameworks and guidelines where the research took place. This study was approved by the University of Idaho Institutional Review Board. (Approval No. 23–084)

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Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the first author used Gemini to generate R code for analyzing delay discounting data. The author provided error monitoring and iterative instructions to refine the code's logic and accuracy, reviewed the final output, and takes full responsibility for the content of the published article.

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Data availability

Data are available at https://osf.io/s8bnt.

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